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HUMIDIFYING SYSTEM FOR DUST AND FUME COLLECTION BY ELECTRICAL PRECIPITATION

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Fig. 1.

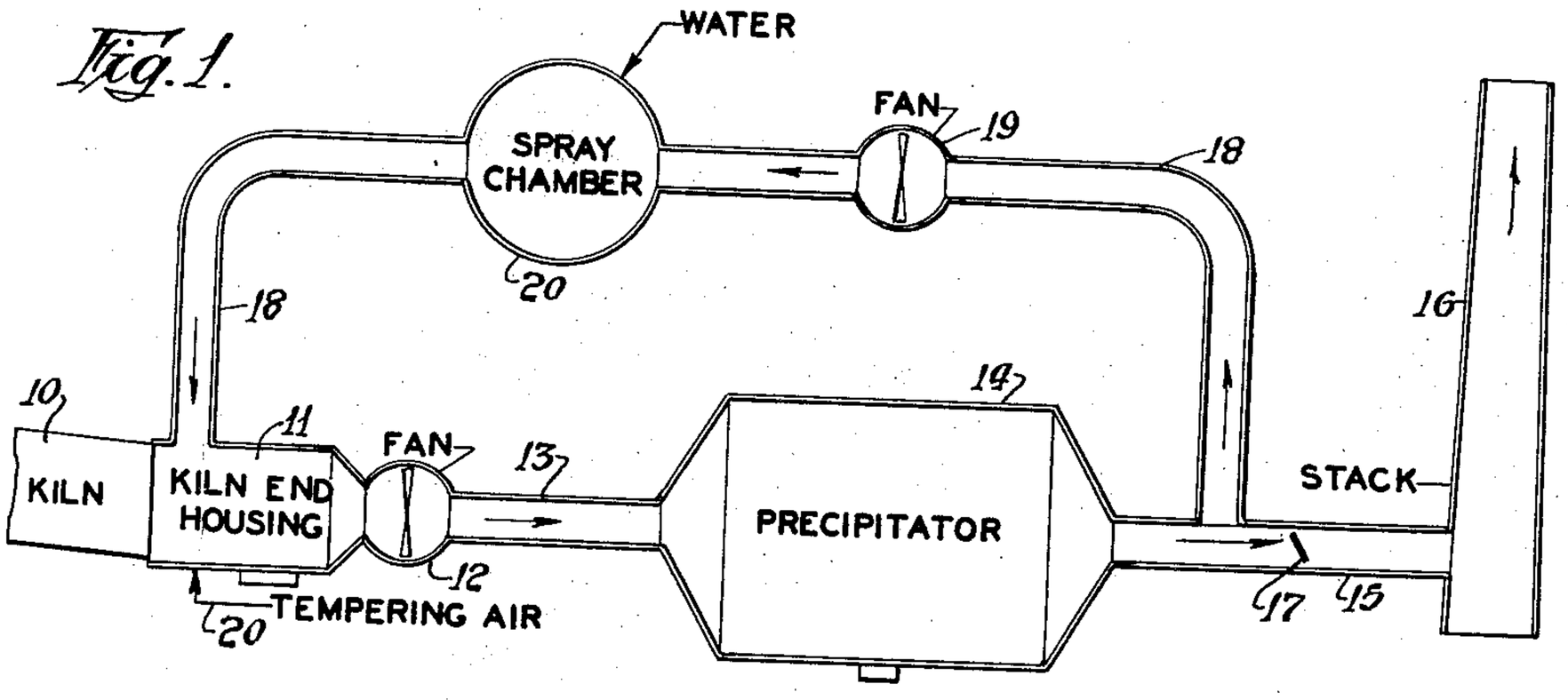
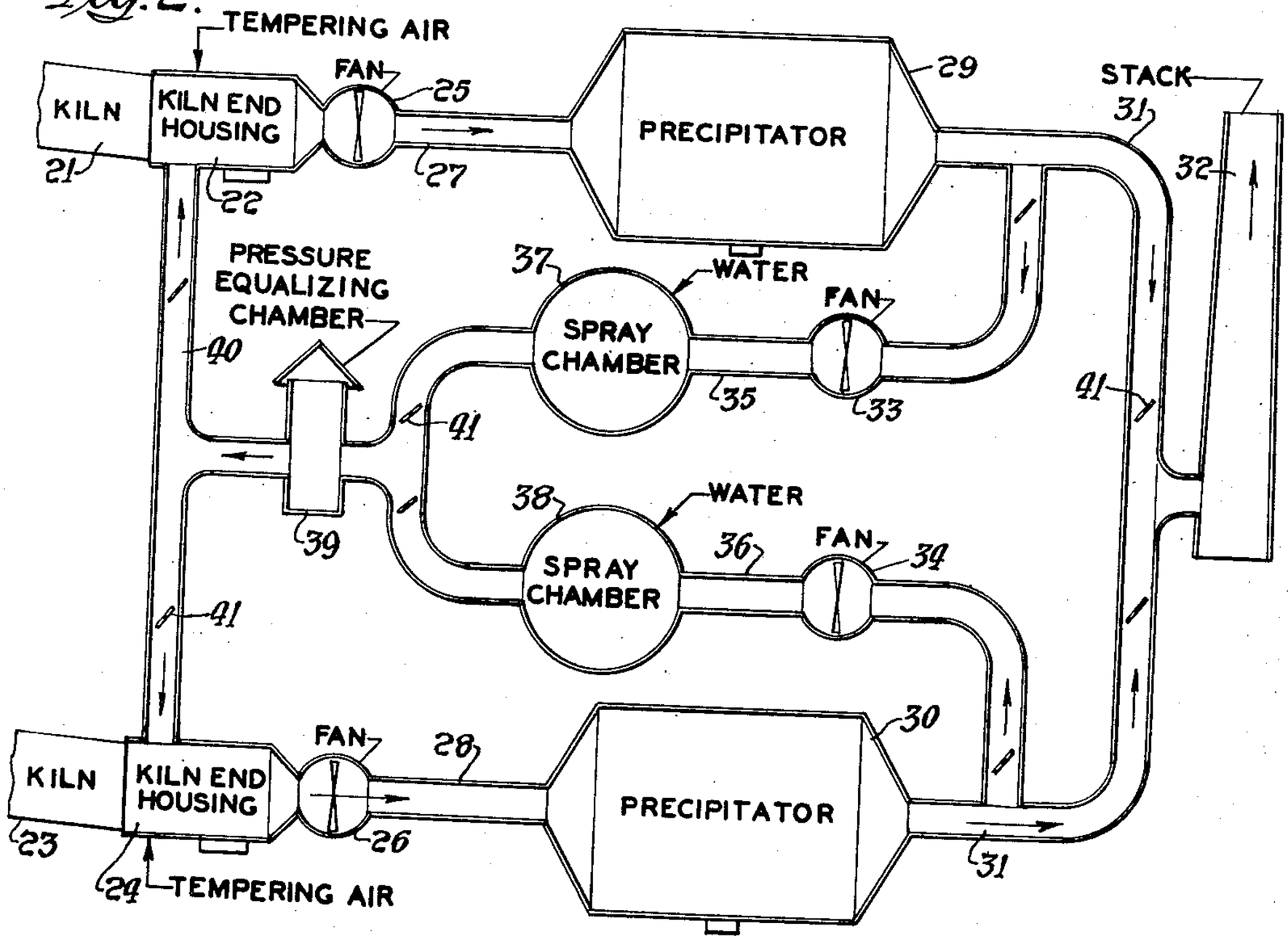


Fig. 2.



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HUMIDIFYING SYSTEM FOR DUST AND FUME COLLECTION BY ELECTRICAL PRECIPITATION

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6 Claims. (Cl. 183—7)

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This invention has to do with improved methods for effecting maximum separation, by electrical precipitation, of contaminants from gas streams while benefiting generally the separation system and equipment, and is directed particularly to such separation from high temperature gases of contaminants including dirt and dust particles, as well as fume resulting from vaporization or sublimation of compounds and elements of essentially mineral or inorganic nature. While applicable to the improvement of electrical precipitation systems for cleaning high temperature gases of various compositions and origins, the invention has been developed with one particular objective, among others, of removing dust and fume from Portland cement kiln gases, and accordingly will be described with reference to that typical adaptation.

The customary methods for separation of dust and fume from the kiln gases before their release to the atmosphere are the so-called wet and dry systems, the former utilizing relatively great quantities of water for separation incorporated in the cement forming materials. The present invention is concerned with essentially dry systems employing electrical precipitation of the contaminants from gases that may have controlled humidification.

In a conventional dry separation system, hot gases (at a temperature e. g. in excess of 1000° F.) are taken from the kiln through an outlet duct containing a fan or blower, and discharged through an electrical precipitator, say the well known Cottrell precipitator employed for the separation of dusts and fumes. It has been necessary to cool the hot gases ahead of the precipitator, and particularly ahead of the fan, since the latter cannot withstand the gas heat at or near the kiln outlet temperatures. Accordingly, a customary practice has been to take atmospheric air into the kiln end housing in quantities necessary to drop the gas stream temperature within limits safe for the blower and precipitator. Such induction of air ordinarily adds considerably to the gas volume finally discharged into the atmosphere.

Also, ordinarily required for most efficient operation of the precipitator, and particularly with respect to fume removal, is controlled humidification of the gas stream going to the precipitator. The usual expedient has been to spray water into the gas stream between the kiln and precipitator and in quantities required for the necessary gas humidification. One very objectionable result of this practice is the accumulation of large quantities of muds and slurries in the water spray chambers, and the problems incident to disposal of the mud.

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By the present invention it is now made possible to obviate these objectionable aspects of the conventional methods, by providing essentially a truly dry system, capable nevertheless of the required gas humidification, which results in a reduced gas volume release to the atmosphere, and substantially complete elimination of mud or slurry accumulations.

According to the present system, the kiln gases carrying separable dust particles and fume are discharged to an electrical precipitator by a fan or blower in an interconnecting duct which may or may not also contain in advance of or beyond the fan, a mechanical dust separator, for example of the cyclone type. One portion of the clean gases leaving the precipitator is discharged to the plant stack, while a second portion of the clean gases is recirculated through a return duct into the clean gas stream at a point in advance of the fan, and preferably into the kiln end housing. Humidification of the gases going to the precipitator, and to a degree required for its most efficient operation particularly with respect to fume removal, is accomplished by the introduction of moisture to the recirculated gases, preferably within the return duct as by means of a spray chamber. Being introduced into the clean gases containing minor or inconsequential solids, the injected water can produce no consequential mud or slurry formation, thus obviating the objectionable mud accumulations in the conventional systems as previous outlined. Thus while having sufficient moisture content to humidify and cool the kiln discharge gases to the required extent, the recirculated gas stream contains no liquid moisture tending to wet and form mud accumulations or solids in the kiln-precipitator duct. Consequently, the system operates essentially dry.

All of the various features and objects of the invention, as well as the details of certain illustrative embodiments, will be understood more fully from the following description of the accompanying drawing, in which:

Fig. 1 is a view illustrating diagrammatically an electrical precipitation and humidifying system operating in conjunction with a single kiln; and

Fig. 2 is a similar view showing the applicability of the invention to the operation of multiple kilns employing clean gas recirculation in

a corresponding number of precipitators to a single pressure equalizing chamber.

Referring to Fig. 1, hot gases carrying separable dust and fume in the Portland cement clinkering kiln 10 are discharged through the kiln end housing 11 to be displaced by a fan or blower 12 through duct 13 into the electrical precipitator 14, e. g. a Cottrell precipitator. The latter operates to separate practically all dust from the gases and at least a major portion of their fume content. Leaving the precipitator, a portion of the clean gases flows through duct 15 to the stack 16.

A second portion of the clean gases discharged from the precipitator, and in an amount controllable as by means of a damper 17 in duct 15, is recirculated back into the kiln hot gas stream through a return duct 18. The latter contains a fan or blower 19 which displaces the gases through a humidifying zone 20 which may consist of a spray chamber into which water is introduced in finely divided form to become completely vaporized in the gas stream. The quantity of water introduced to the spray chamber may be so controlled that when introduced to the kiln gas stream, the recirculated gases will raise the humidity of the gaseous mixture fed to the precipitator, to within the range required for most efficient operation of the precipitator, and particularly with respect to its fume removing capacity. Preferably, the recirculated gas is introduced through duct 18 into the kiln end housing 11 and in advance of the fan 12 in order to cool the kiln gases below temperatures injurious to the fan.

The following flow rates, temperatures, humidities and so forth may be cited as typical operating conditions applicable to the described separation and recirculation system. In a typical instance hot gases containing about 16.5% water may be assumed to flow from the kiln at the rate of 68,000 C. F. M. (cubic feet per minute) and at a temperature of 1500° F. Including the recirculated gas stream, the gases flow through duct 13 to the precipitator at a rate of 101,000 C. F. M. at 660° F., as a result of humidification by the recirculated streams the gases fed to the precipitator have a water content of about 22.9%. That portion of the clean gases discharged to the atmosphere through the stack 16 may amount to about 53,000 C. F. M. at 620° F., with moisture content of 22.9%. A second portion of the gases at this same temperature and humidity may be recirculated into duct 18 at the rate of around 44,800 C. F. M. Introduction of water to the spray chamber 20 at the rate of around 14½ gallons per minute produces a gas stream recirculated into the kiln end housing at the rate of about 33,200 C. F. M. at a temperature of around 250° F., the water content of this stream being about 32%.

While it is to be understood that complete cooling of the hot kiln gases to the extent required, may be accomplished by means of the recirculated and humidified gases, if desired some atmospheric cooling or tempering air may be admitted to the kiln gas stream as through line 20 leading into the kiln end housing. Merely as illustrative, under the particular operating conditions assumed in the foregoing, 80° F. atmospheric air may be introduced to the kiln end at the rate of around 4,700 C. F. M.

Fig. 2 illustrates a variational embodiment of the invention directed particularly to the separation and recirculation of gases by essentially the procedure described with reference to Fig. 1, in a multiple kiln and precipitator system. Here the hot gases from the kilns and end housings 21, 22 and 23, 24 are discharged by fans 25 and 26 through ducts 27, 28 to the precipitators 29 and 30. Portions of the clean gas streams leaving the precipitators are discharged through interconnecting duct 31 to the stack 32. The remaining clean gases are recirculated by fans 33 and 34 through ducts 35 and 36 to the spray chambers 37 and 38. The humidified gas streams flow from the spray chambers to a common pressure equalizer chamber 39 which preferably is vented to the atmosphere. The mixed gas streams thence are taken through duct 40 for delivery into the kiln gas streams going to the precipitator. In Fig. 2 we have illustrated dampers 41 at various locations in the system for regulation of the proportions of the gas streams to be recirculated and the proportions to be returned to the kiln gas streams, these dampers also being so located as to permit isolation of all or any part of each kiln, precipitator and spray chamber system from the other.

If for any reason either recirculation fan or spray chamber should cease to function properly, the volume of humidified gas being returned through the other recirculation duct may be increased to adequately serve to cool and humidify the streams going to both precipitators, and with or without the addition of tempering air. On the other hand, should the recirculation gas requirement for either kiln and precipitator system be interrupted, then all excessive amounts of gas being returned through both recirculation systems, may be vented to the atmosphere from the pressure equalizing chamber 39.

Speaking generally of the operating conditions to be maintained in the described systems, the rate of the clean gas recirculation, its temperature and humidity, will be regulated to reduce the hot gas stream temperature well below 1000° F., and preferably below 700° F., and to increase the humidity of the mixture going to the electrical precipitator as required for its most efficient operation. Ordinarily, the addition of moisture by way of the recirculated gases will be governed to maintain the water content of the gases passing through the precipitator between about 15% to 30% by volume of the gas.

We claim:

1. In the operation of a Portland cement plant comprising a plurality of clinkering kilns each communicating with its individual electrical precipitator, the method that includes passing a stream of hot gas from each kiln through an electrical precipitator operating to remove dust and fume from the gas, discharging to the atmosphere a portion of the clean heated gas flowing from the precipitators, mechanically recirculating separate streams of a second portion of the clean gas from said precipitators into a common chamber and thence into said hot gas stream, and humidifying the recirculated gas by introducing water thereto and vaporizing the water by sensible heat of the gas.

2. In the operation of a Portland cement plant comprising a plurality of clinkering kilns each communicating with its individual electrical precipitator, the method that includes passing a stream of hot gas from each kiln through an electrical precipiator operating to remove dust and fume from the gas, discharging to the atmosphere a portion of the clean gas flowing from the precipitators, mechanically recirculating separate streams of a second portion of the heated clean

gas from said precipitators into a common chamber vented to the atmosphere and thence into said hot gas stream, and humidifying the recirculated gas by introducing water thereto and vaporizing the water by sensible heat of the gas.

3. The combination comprises a Portland cement clinkering kiln, an electrical precipitator, a main duct through which hot gases flow from said kiln to the precipitator, a fan in said duct, a discharge duct leading from the precipitator and containing gas at a temperature considerably in excess of the boiling temperature of water, a clean gas recirculation duct leading from said discharge duct and communicating with said hot gas stream in advance of the fan, a second fan in said circulating duct, and means for introducing water into the clean gas stream in the recirculation duct for vaporization by the sensible heat of the gas recirculated by said second fan.

4. The combination comprising a Portland cement clinkering kiln, an electrical precipitator, a main duct through which hot gases flow from said kiln to the precipitator, a fan in said duct, a discharge duct leading from the precipitator and containing gas at a temperature considerably in excess of the boiling temperature of water, a clean gas recirculation duct leading from said discharge duct into the outlet end of the kiln, a second fan in said recirculation duct, and means for introducing water into the clean gas stream in the recirculation duct for vaporization by the sensible heat of the gas recirculated by said second fan.

5. The combination comprising a pair of Portland cement clinkering kilns, an electrical precipitator for each kiln, a main duct through which gas flows from each kiln to its precipitator, a fan in each duct, discharge ducts leading from the precipitators and containing gas at a temperature considerably in excess of the

boiling temperature of water, a pressure equalizing chamber, recirculation ducts leading from said discharge ducts to said chamber, means conducting gas from said chamber into the kiln gas stream in advance of said fans, and means for introducing moisture to and for vaporization by the heated gas recirculated through said recirculation ducts and in advance of its admixture with the kiln gas.

6. The combination comprising a pair of Portland cement clinkering kilns, an electrical precipitator for each kiln, a main duct through which gas flows from each kiln to its precipitator, a fan in each duct, discharge ducts leading from the precipitators and containing gas at a temperature considerably in excess of the boiling temperature of water, a pressure equalizing chamber vented to the atmosphere recirculation ducts leading from said discharge ducts to said chamber, means conducting gas from said chamber into the kiln gas stream in advance of said fans, fans displacing gas through said recirculation ducts and chambers, and means for spraying water into the heated gas being recirculated and for vaporization by the sensible heat of the gas.

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